WOOD PRESERVATION.

By Bohumil Shimek.

The civil engineer is so frequently called upon to make use of wood in his work, and to decide concerning relative quality and durability, that a thorough knowledge of wood is of great value to him. He should be able to recognize the principal forest trees in their living state; he should know the chief commercial woods of the country, not only by external and gross characters, but by those which the microscope alone reveals; he should understand the relation between the quality of wood and rate of growth and habits of the tree; and he must have a knowledge of microscopic structure of wood to properly appreciate the possibility and progress of its decay, and the methods of its preservation.

All this calls for a thorough knowledge of plant structure and physiology as an indispensable basis. It is, in short, not possible to begin at the top and give a satisfactory knowledge of the practical phases of the subject without a scientific knowledge of the plant. The engineer has been, heretofore, usually interested, chiefly, in the resisting strength of wood, but more and more, as wood increases in cost on account of its growing scarcity, he must interest himself in its durability. To this end he is concerned not only with the natural quality of woods, but with the artificial methods by which their durability may be increased. The very fact that the best of our more accessible forests are almost destroyed, and that the end of those even in the more remote sections of the country can easily be foreseen, impresses upon us the need of methods by which the softer woods may be rendered more lasting. For the time is not far distant (indeed it is here), when we will be compelled to cultivate trees for commercial purposes, and manifestly the more rapidly growing soft wood trees, which develop to commercial size in the shortest time, will be more desirable, provided that feasible methods of preservation can be employed. As suggested, the full appreciation of the methods of treatment of wood for this purpose calls for a very full knowledge of wood structure, and of the manner in which the enemies of wood attack it to produce decay. The limits of this contribution cannot, however, include a full discussion of this part of the subject. Suffice it to say that wood, being organic, is subject to the attacks of various enemies, chiefly fungi and bacteria, and to consequent decay; that, besides the organic cell-walls which make up the greater part of wood, the cells of the sap-wood contain more perishable soluble organic materials which are greedily consumed by fungi and similar organisms; that all wood is more or less porous, especially in cross-section, the latter exposing the cut ends of the long tubes, or, in conifers, shorter cells, by which sap is carried through the stem; and that these openings are ample to admit fungi and bacteria. The latter are active only when they have air, sufficient moisture and an abundance of organic food. The latter is, in this case, supplied by the wood. If a sufficient amount of moisture is retained in the wood the fungi and bacteria multiply very rapidly, and decay follows. It must be understood that moisture and air alone are not responsible for decay. Wholly submersed wood decays slowly, but where it is exposed to air, and at the same time to continued moisture, as in case of contact with the soil, etc., fungi find congenial conditions, and decay is rapid. Fungi grow primarily in the form of hyphæ, exceedingly delicate threads, which can easily penetrate into the wood as noted. They reproduce by minute spores, which are exceedingly abundant, and, being light, are readily carried about by wind. They will thus be readily brought to rough wood surfaces, and wherever they come in contact with moist organic material they rapidly germinate and grow, and the delicate hyphæ soon penetrate the wood and cause its disintegration. The real damage is done by these hyphæ, and the fungus which finally appears on the surface of wood is merely a spore-bearing fruiting body which represents the culmination of the efforts of the fungus. It is not sufficient, therefore, to destroy merely this fruit. The bacteria which assist in the process of decay, completing the work of the fungi, are exceedingly minute, and may be similarly carried. The conditions under which they act are essentially the same as those required for fungi, and these forms do not, therefore, call for separate discussion.

The foregoing facts explain a number of points of interest to the engineer, to which reference is made in the following discussion. This discussion, while applying in general to wood-preservation for any purpose, is here directed more particularly to the subject of ties. In all cases, whether special methods of wood preservation are employed or not, the wood should be well seasoned. To this end, if kiln-drying is impossible, it is better that the wood be cut in the fall, in order that it may have a longer time to dry slowly in the colder part of the year. Fungi cannot damage it during the winter, and the slower drying prevents checking, which would subsequently admit fungi and hasten decay. If kiln-drying is practiced, the wood may be cut at any season of the year. There is also some advantage in using wood which has been rafted, or at least allowed to remain in water for some time, as some of the soluble organic materials are thus removed, and as a result fungi find less available food-material. The same result is secured by first steaming the wood. In the case of ties, the steaming may be done in the open air, without shelter. They should be piled in a place well drained, and exposed to winds, rather than the sun, and not more than two ties should come in contact with the ground. An open crib, with plenty of space between the ties, may then be built upon the two supporting ties. The method of piling, as illustrated in Plate I, Fig. 1, is faulty, because the ties are crowded too closely. The spaces between them should quite equal the width of a tie. It is also well to roof the pile. This may be done by placing an additional tie under one end of the uppermost tier of ties, and crowding the ties in that tier close together, so that water will be shed more readily. In all cases, no rough or splintered surfaces should be left on the ties, either on sides or ends, to prevent lodging of spores. For this reason hewn ties are superior to those which have been sawed.

If ties are thus well seasoned, their lasting-qualities are much improved. Well seasoned ties of black locust and red cedar should last ten years; those of honey locust, white oak, walnut, cherry and tamarack, from six to eight years; and those of the red and black oaks, ash, beech, and maple from four to six years. These periods, however, vary with environment, drainage and exposure, being perhaps the most important factors.

Various methods of treating wood to still further increase its life have been employed. Charring and coating with paint or tar have some merit, and have long been employed. Paint and tar are effective only when they wholly exclude air, for otherwise, especially if wood is not well seasoned, they are of advantage to the fungus, since they retain moisture within the wood. In practice, therefore, especially as far as ties are concerned, they are scarcely to be considered.

Various methods of impregnating wood with antiseptics have been employed, and where properly carried out, they increase the life of the ties from two to four times. The materials used for this purpose must be poisonous to fungi and bacteria; they must be easy of injection, and must readily penetrate to all parts; and they must be sufficiently cheap to make the process profitable. They should also possess a quality which, unfortunately, most of them lack—they should not be easily washed out by water. In Europe various methods of impregnating wood have been employed for some time, but in this country the practice is comparatively recent, though its importance is being more and more appreciated. The materials which have been chiefly employed for impregnation are the following:

Bichloride of mercury, 1 part to 150 parts of water.

Sulphate of copper, 40 ℔s. to 100 cu. ft. of water. This is decomposed by iron, hence spikes affect it in ties, and the process of impregnation cannot be carried on in iron retorts.

Zinc chloride (Zn Cl), about a 4 per cent solution in water.

Creosote oil, which is insoluble in water, and hence especially desirable, but the method is the most expensive of those commonly employed. The cost of treatment by these various methods varies from 8 to 25 cents per tie.

Various combinations of these and other materials have also been attempted. Perhaps the most successful has been the method, sometimes used in Europe, by which zinc chloride is first forced into the wood, followed by creosote oil, which permeates only the outer part of the wood, and thus prevents the escape of the zinc chloride.

The methods by which the preservative is forced into the wood are various. At first mere infiltration, or soaking, was attempted, but this resulted in the impregnation of the outer part of the wood only, and experience has shown that this is dangerous, as the center may decay and weaken the wood without showing any exterior evidence of decay. Boiling in vats is sometimes employed, and this gives somewhat better results, but is still unsatisfactory. The best methods are those by which a partial vacuum is created in the wood, and the antiseptic is then forced in under pressure. While in details the methods and apparatus vary more or less, a brief description of one plant, the Alamogordo (New Mex.) Timber Preserving Plant, will convey a fair idea of the best general practice. This plant, which is shown in Plate I, Fig. 2, is located in a territory in which practically only coniferous wood is available. The method which is here employed is the Wellhouse Zinc-tannin process, though the plant is also used for simple Burnettizing, in which only zinc chloride is used, and may be adapted to other methods, except that in which copper sulphate is used. The impregnating fluids are stored in tanks, represented in Plate II, Fig. 1, and they may be sent to the retorts or returned to the tanks by a system of pumps. There are two retorts, each 106 feet long and having a capacity of 546 eight-foot six by eight-inch ties, and they occupy the portion of the building shown in Plate II, Fig. 2, and just beyond the wall shown to the left in Plate IV, Fig. 2. The ties are placed on steel cars, as shown in Plate III, Fig. 2, and are run into the retort, the entrance to which is shown in Plate IV, Fig. 1. A train of such cars, ready to enter the retort, is shown to the right in Plate II, Fig. 2. After the retort is filled, the entrance is securely closed, and the treatment begins. For seasoned timber the process is substantially as follows: the ties are steamed in the retort under 20 ℔s. pressure for four or five hours. A partial vacuum (22 inches) is then created in the retort by the vacuum pump, and a 4 per cent solution of zinc chloride is introduced under 100 ℔s. pressure for four hours. The amount of pure chloride consumed per cubic foot of wood varies (for the conifers here used) from .29 to .33 ℔. The chloride is then followed by tannin, of which a sixth of a pound per cubic foot is used, for about one and one-half hours, and this in turn is followed by a $\frac{1}{2}$ per cent solution of glue. The entire run consumes from 11 to 11:30 hours. If green wood is used the time required for steaming and impregnation with chloride must be extended from one to one and one-half hours each. The entire process is carried on by a series of pumps operated by steam power, and shown in Plate IV, Fig. 2. In the foreground, to the left, is the forcing pump, and following this in order are the air compressor the vacuum pump, and the circulating pump. After the retorts are filled, one man can manage the entire operation. The process darkens the ties, as is shown in Plate III, Fig. 1, where the car to the left contains ties ready for the retort, and that to the right those which have been treated. After the treatment the ties should again be thoroughly seasoned for several months (in the dry climate of New Mexico less time is required) before they are used.

Where soluble materials are used for impregnation (and this is usually the case) the life of the tie may be materially increased by providing good drainage for the road-bed, and this is especially true of ties buried in ballast.

Conifers take up a larger amount of the impregnating fluid than do the woods of deciduous trees, and the heart-wood in the latter takes up less than the sap-wood. There is also more or less difference between the different kinds of woods in each group.

Methods of the kind here discussed are employed chiefly in the south and east. In the north and west comparatively little has been done in this direction. As a prominent lumberman of Minnesota expressed it to the writer some time ago, lumbermen have been interested chiefly in selling as much lumber as possible, and not in its preservation. But the growing scarcity, and consequent high price of wood throughout the country, is sure to extend the use of methods of wood-preservation, which will no doubt be greatly improved.

Fig 1

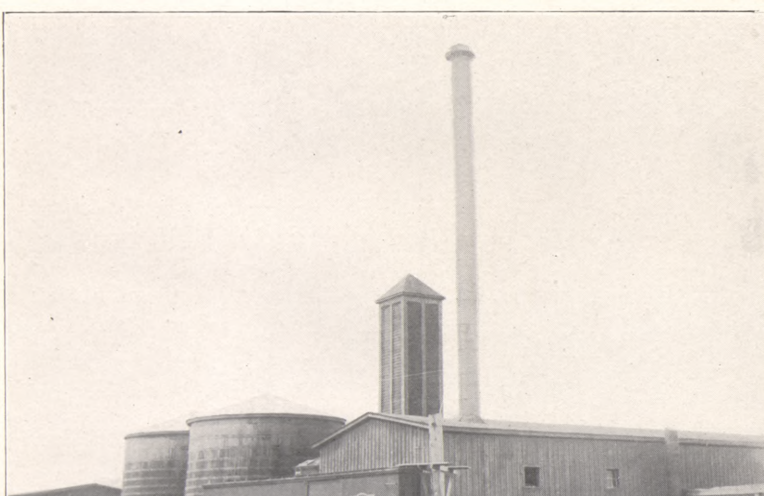
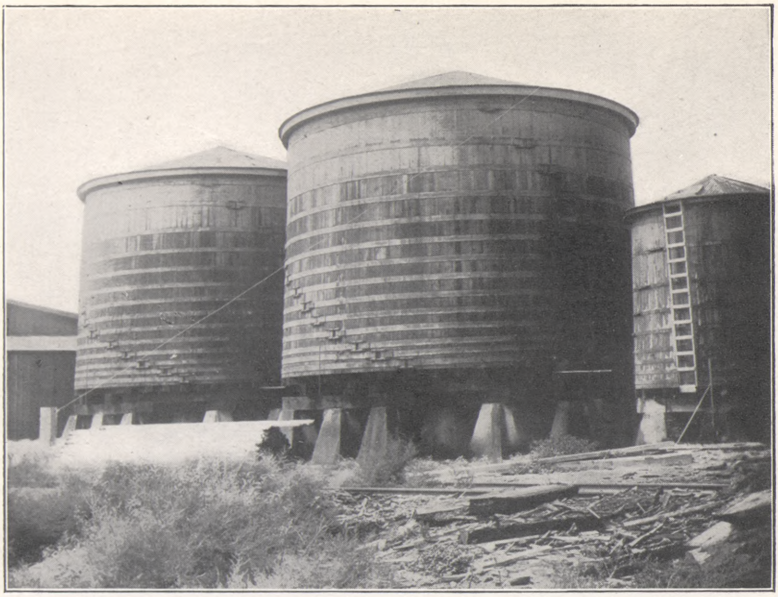


Fig. 2

Plate I



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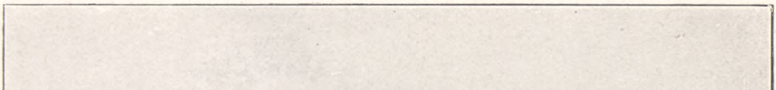
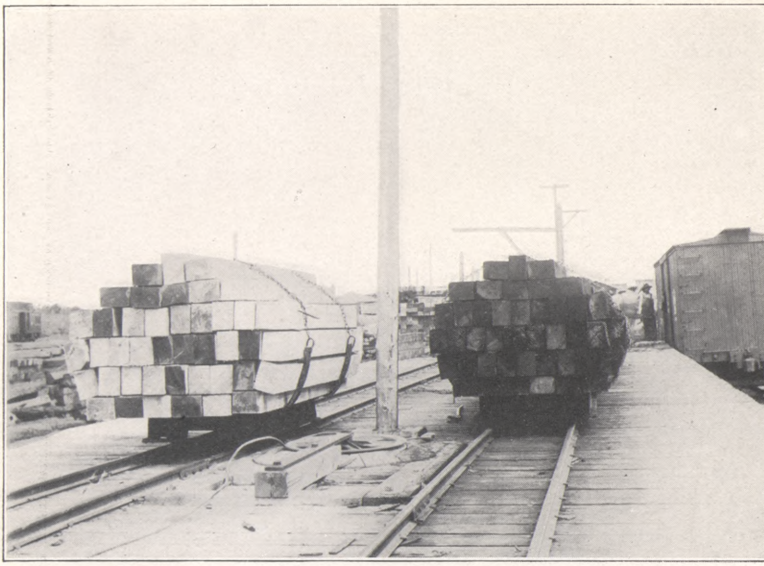


Fig. 2

Plate II



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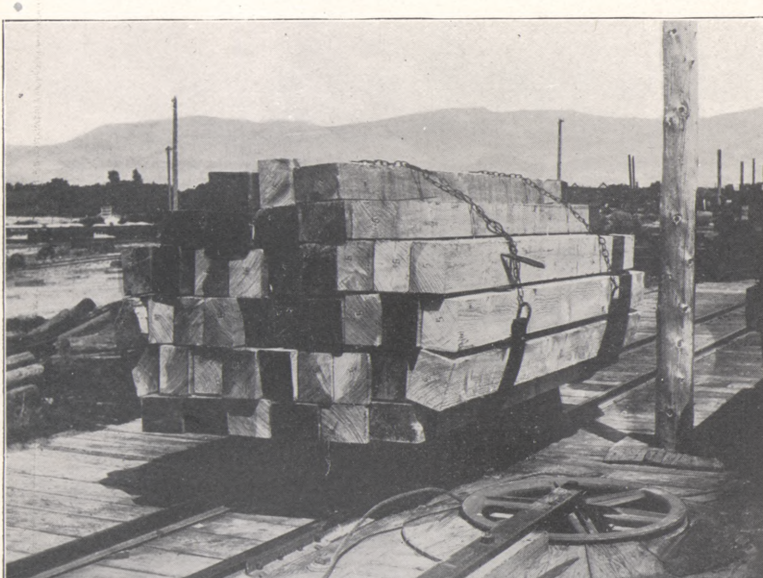
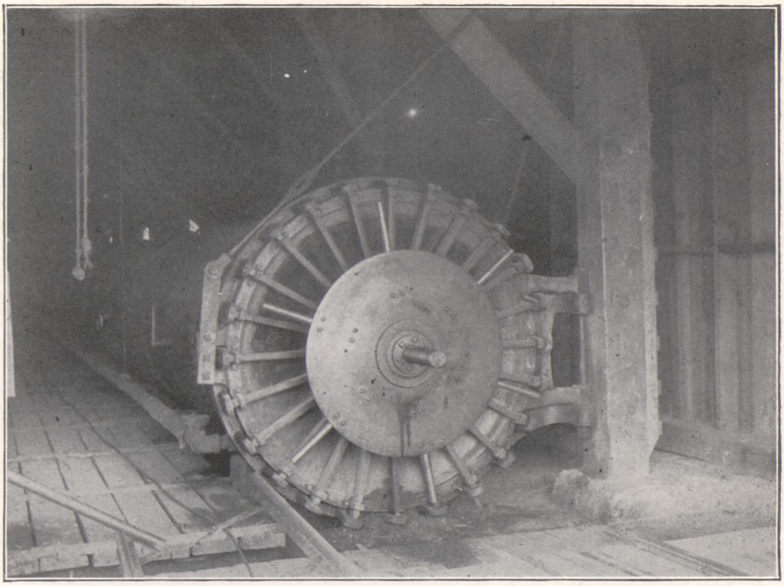


Fig. 2

Plate III



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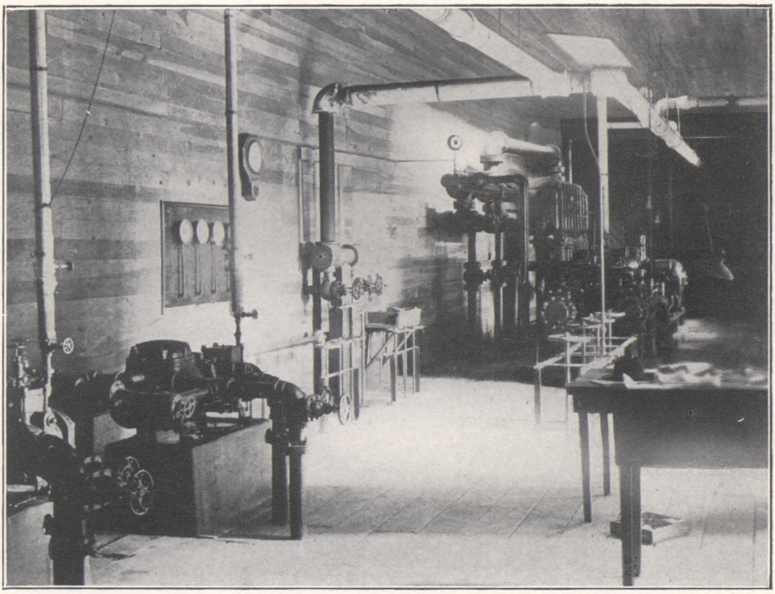

Fig. 2

Plate IV